Modelling Badminton Movement for Injury Prevention & Performance Enhancement

Background

The analysis of athletic movement for injury prevention and performance ehancement has been widely applied by various athletes and teams to inform coaching and technique.

Advancements in motion capture technology have allowed for on-field capture of important parameters that could help assess injury risk and advise technique for improved performance.

The badminton jump smash is a manouvre that accounts for over 50% of winning shots in Badminton, making it an invaluable tool for players seeking to perform at elite level. As with any sports movement that involves jumping, the mechanics of the subsequent landing plays an important role in preventing injury on landing.

Aim

The study aims to evaluate the injury risk associated with various landing techniques following a jump smash, namely toe-first landing, flat-footed landing and heel first landing.

Method

The XSens MVN Link Inertial measurement system was used for on-court capture of the jump smash movement. Thirteen players (12 male and 1 female), ranked between 1 and 20 nationally, participated in the study.

Players donned the XSens MVN Link suit, which contains 17 inertial measurement sensors. Each player executed four jump smash manouvres, landing in a different mode: (1) their natural landing technique, on the ball of the foot (BF), (2) toe-first (TF), (3) flat-footed (FF) and (4) heel-first (HF).

Using kinematic chains, the data was segmented into the preparation, back swing and follow trhough and forward swing phases to identify the landing.

The vertical ground reaction force and biomechanical response of the ankle, hip and knee joints for each participant were determined. The joint stiffness was used as a measure of biomechanical response based on literature that supports the statement that increased joint stiffness is correlated to increased ground
reaction forces and risk of injury. A one-way repeated measure analysis of variance (ANOVA) test was conducted to evaluate the different landing techniques. The VGRF, joint stiffnesses, incident angles in the saggital platan and ROM in the saggital and frontal planes were assessed for each landing technique.

For information about this study:

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Results

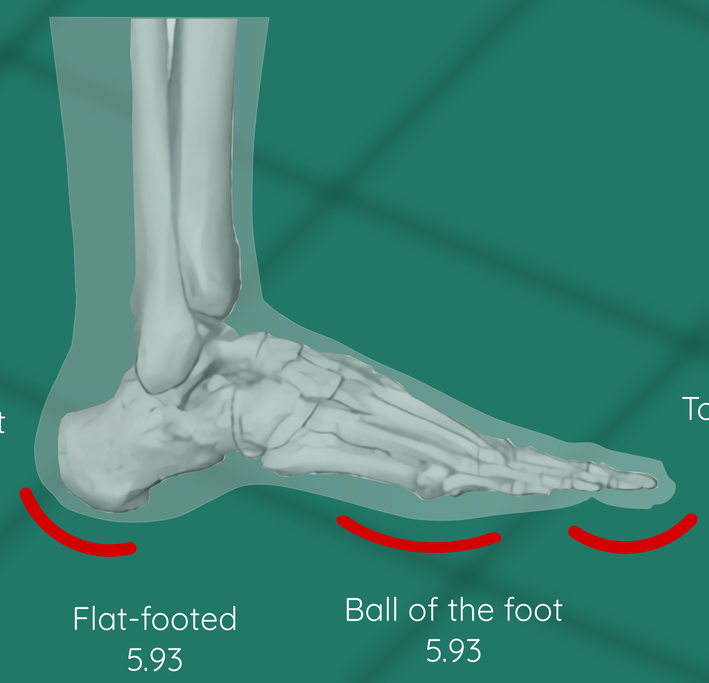


Figure 1 Normalised Vertical Ground Reaction Forces in various landing techniques (BW)

Excessive ligament strain and damage can be caused by increased ground reaction forces, therefore the toe-first and heel-first landing techniques experience an increased risk of injury

Higher vertical ground reaction forces can be attributed to decreased joint rotation in these landings

In particular, knee stiffness showed a strong positive correlation to the vertical ground reaction forces with incresaed knee stiffness in the toe-first and heel-first landings.

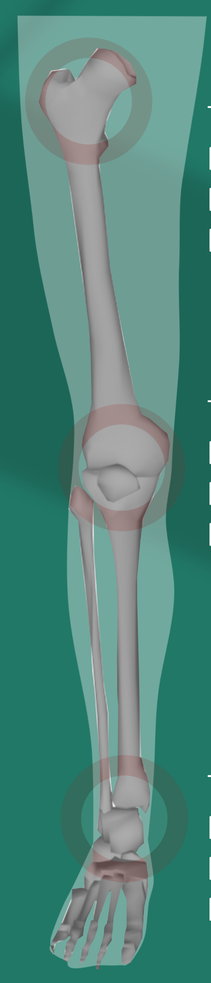
The toe first and heel first landing strategies experience the greatest knee stiffness values, which further substantiates that these landing strategies may contribute to increased risk of injury.

The heel first landing technique experiences almost no ankle dorsiflexion under loading and the toe first technique experiences decreased hip rotation.

Ground reaction forces can be reduced by greater energy absorption and this is achieved by increase joint rotation.

Landing on the ball of the foot or flat footed, the ankle experiences eversion rotation in the frontal plane during the follow-through phase.

The large ROM at the knee and the correlation between the vertical ground reaction force and knee stiffness indicate energy is absorbed at the knee, regardless of landing mode.



	Stiffness	ROM (saggital)	ROM (frontal)
TF	7.33	5.98	-15.89
HF	4.25	25.49	-22.90
BF	6.70	13.70	-24.10
FF	3.17	21.60	-20.81
TF	4.00	39.69	4.21
HF	4.37	36.62	2.64
BF	3.08	36.85	3.37
FF	2.31	38.49	3.51
TF	0.03	34.71	0.43
HF	2.87	8.22	-0.59
BF	1.36	44.64	4.30
FF	1.61	43.65	2.20

Figure 2 Joint ROMs (degrees) and Stiffness (Nm/kg rad) for various landing techniques

Conclusions

Higher vertical ground reaction forces are experienced when landing toe-first or heel-first following the execution of a jump smash.

The vertical groudnd reaction force is ppostively correlated to the knee stiffness. The knee joint experiences higher stiffness in the toe first and heel first landings.

Emphasis should be placed on landing on the ball of the foot folllwoing a jump smash. A toe first or heel first landing could post a significant injury risk.

What's Next?

Further data collection which includes the shuttlecock speed is required to assess the effect of landing technique on the performance of the jump smash.

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